1350.01 General

Soil bioengineering is a land stabilization technology applied to disturbed sites and on slope and streambank projects. A multidisciplinary partnership is used to implement soil bioengineering techniques. Project managers initiate and design bioengineering features by employing the expertise of WSDOT hydraulic engineers, geotechnical engineers, engineering geologists, landscape architects, horticulturists, biologists, water quality specialists, environmental planners, and others. Soil bioengineering for slope stabilization provides additional environmental benefits such as habitat enhancement and water quality improvement.

Include consideration of slope geometry, climate, water regime, soil properties, and surrounding vegetation in soil bioengineering proposals. Applications of soil bioengineering are divided into three general categories: erosion control, streambank or shoreline stabilization, and upland slope stabilization. Refer to manuals according to the related discipline.

1350.02 References

For more detailed information, see:

Design Manual chapters, M 21-01, WSDOT:

1300 Roadside Development

510 Investigation of Soils, Rock, and Surfacing Materials

640 Geometric Cross Section

1130 Retaining Walls

1210 Hydraulics

Geotechnical Guidance — see geotechnical report for slope/soil stability. If further assistance is needed, contact Regional Materials Engineer.

Hydraulics Manual, M 23-03, WSDOT — for hydrology criteria.

Highway Runoff Manual, M 31-16, WSDOT — for Stormwater Site Plans, Temporary Erosion and Sediment Control Plans, and best management practices.

Roadside Manual, M 25-30, WSDOT — for vegetation and site preparation criteria, plant selection, design configurations, and other related topics.

Roadside Classification Plan, M 25-31, WSDOT — policy and guidelines for roadside treatment. Contact the region's Landscape Architect Office or the HQ Roadside and Site Development Services Unit.

Environmental Procedures Manual, M 31-11, WSDOT — permits.

Internet Bioengineering Drawings, WSDOT Homepage http://www.wsdot.wa.gov/eesc/cae/design/roadside/SBwebsite/mainpage/Design/Techniques/Specdetail.html

1350.03 Uses

(1) General

Soil bioengineering combines the use of live plants or cuttings, dead plant material, and inert structural members to produce living, functioning land stabilization systems. This technique uses living plants to control and prevent soil erosion, sedimentation, and shallow slope instability. The bioengineered solution benefits from engineering techniques that use live plant material.

Soil bioengineering methods can be cost effective and a useful mitigation solution for site specific problems. Soil bioengineering is effective in erosion prevention, streambank stabilization, and some upland instabilities. Soil bioengineering, like other engineering techniques, is not applicable in all situations. Soil bioengineering

techniques may not effectively mitigate severe bridge scour, severe roadway erosion conditions, or deep seated slope instabilities. In such cases, soil bioengineering can be used in combination with other engineering techniques.

The use of native vegetation that is adapted to the conditions of the project site will increase the success of the application of soil bioengineering techniques. Over time, native vegetation will encourage the establishment of a diverse plant community and discourage undesirable and invasive plant species.

Other applications of soil bioengineering include:

- Wildlife and fisheries habitat enhancement
- Reinforcement and steepening of cut and fill slopes to limit impacts to adjacent properties and sensitive areas
- Vegetated buffer enhancement on steep slopes
- Enhancement of stormwater treatment areas and stabilization of drainage ways by providing erosion prevention and sediment control
- Site specific mitigations using standard geotechnical solutions in combination with vegetative control

(2) Erosion Prevention

Soil Bioengineering techniques can provide erosion prevention in the top soil layers. Erosion is the detachment and transport of surficial soil particles through the action of water, wind, and ice. Plant shoots and foliage diminish rainfall erosion and remove excess moisture through transpiration. Roots reinforce the soil mantle, allowing the system to grow more stable with age. Vegetative material slows down runoff and traps soil thereby reversing the effects of erosion. Refer to the *Roadside Manual* for more information.

(3) Streambank Stabilization

Soil bioengineering techniques can be used to stabilize streambanks, enhance wildlife habitat, improve water quality by controlling sediments, and protect structures. Bioengineering in the riparian zone (banks of streams, wetlands, lakes, or tidewater) requires an hydraulic study of stream characteristics and changes in stream alignment. Refer to the *Hydraulics Manual* for more information.

(4) Upland Slope Stabilization (generally less than 3 feet in depth)

Upland slope stabilization refers to the use of vegetation and plant materials to reduce or prevent soil erosion caused by wind or water on slopes not directly adjacent to riparian zones.

There are three classifications of unstable slopes:

- **Surface movement** refers to surface erosion caused by wind or water on slopes
- **Shallow-seated instability** is defined as a failure surface less than 3 ft in depth
- **Deep-seated instability** is defined as a failure surface greater than 3 ft in depth

Soil bioengineering is used for slopes that are at risk of shallow landslides, slumps, sloughing, and surface erosion.

Soil bioengineering alone is not appropriate for deep-seated landslides, but can be used in conjunction with other engineering methods to treat associated shallow instabilities.

Soil bioengineering techniques can be used to stabilize the slopes of construction sites or to repair disturbed or damaged slopes. Soil bioengineering is applied to both cut and fill slopes.

(5) Strategies

When planning for site specific soil bioengineering design, consider the factors, parameters, and design considerations/ specifications in Figure 1350-1.

Factors	Parameters	Design Considerations/ Specifications
Climate or Microclimate	Growing season Exposure/Aspect	Select suitable plants, methods and construction timing
Physical Properties of Soil	Density and compaction Permeability	Modify soil structures during construction Select suitable plants
Chemical Properties of Soil	pH Fertility Cation Exchange Capacity	Select suitable plants Add soil amendments
Water	Profile available water Water sources	Divert water during construction using drains, ditches, pipes, etc. Amend soil
Erosion Risk	Soil erodibility Rainfall erosivity Channel discharge Slope (height and angle) Wind, water, or ice	Temporary or Permanent covers Select suitable plants Reinforcement with geotextile
Geotechnical	Shear strength Slope Factor of Safety	Select suitable soil materials Structures Soil density and moisture Reinforcement with geosynthetics See (Chapter 530)

Soil Bioengineering Design
Figure 1350-1

1350.04 Design Responsibilities and Considerations

Consider the possible applications for soil bioengineering during the project definition process. Address soil bioengineering applications during the design process as part of the recommendations in the Hydraulic Report (for streambank/shoreline), Stormwater Site Plan (SSP), Geotechnical Report (for slope stabilization), and in the Environmental Documents. These reports provide design criteria and guidelines.

1350.05 Documentation

A list of documents that are to be preserved [in the Design Documentation Package (DDP) or the Project File (PF)] is on the following website: http://www.wsdot.wa.gov/eesc/design/projectdev/